Interim Findings of the HamSCI DASI2 HF Antenna Project

Michael Hauan AC0G, Glenn Elmore N6GN, Rob Robinett AI6VN, Elmer Musser N3AGE, Gwyn Griffiths G3ZIL, Dave Witten KD0EAG, Ulli Grunow ON5KT, Clint Turner KA7OEI, Dave McGaw N1HAC, Dave Larsen KV0S

ac0g@hauan.org

Introduction

- Primary Objective:
  - Assessment of antennas for DASI2
  - Concurrent interest: Development of N6GN's SAS
- Emergent Objective:
  - Tools for improving antennas and sites

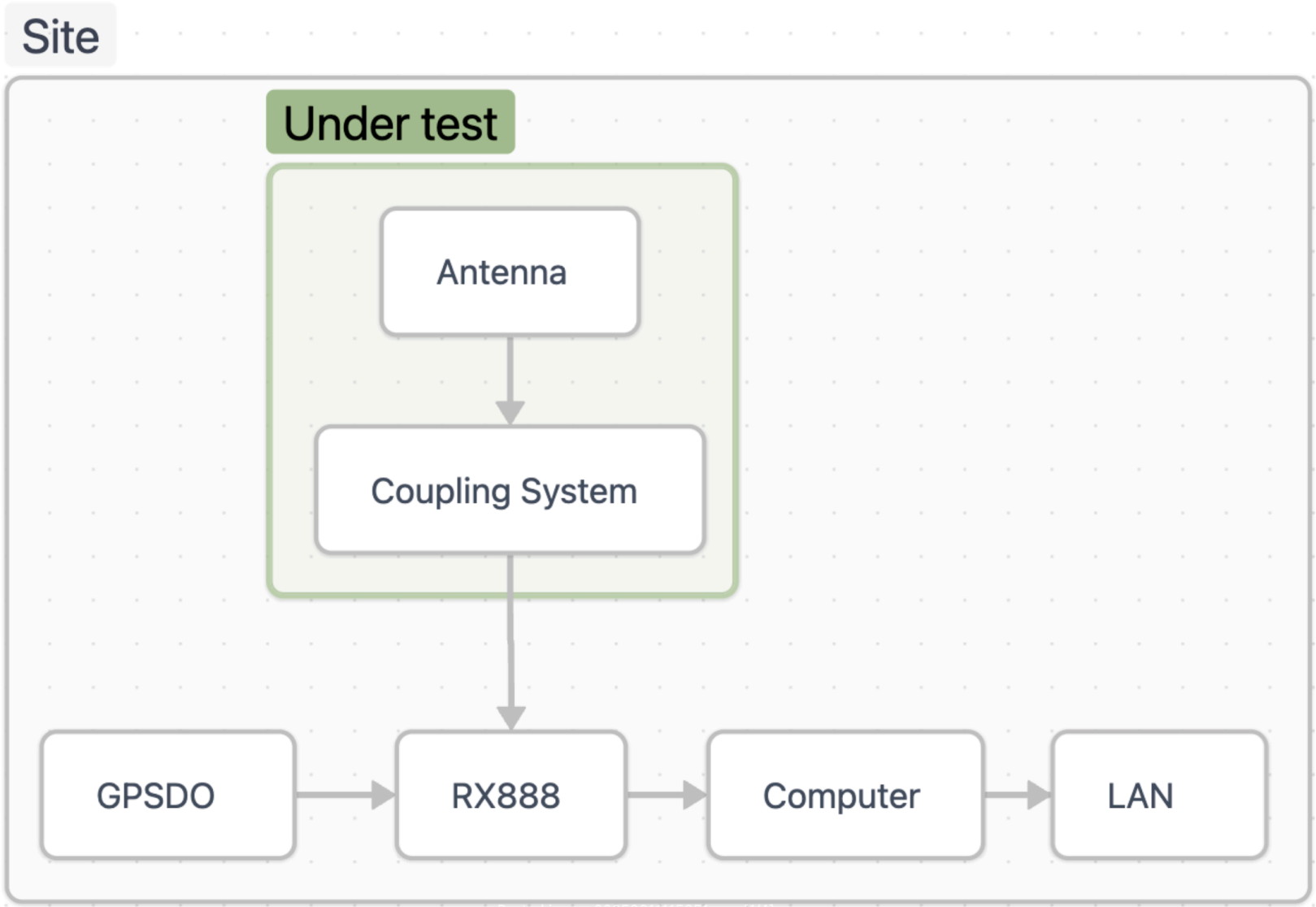
Why a single antenna?

1. Uniformity Data Collection Sites
2. Simplified Deployment
3. Performance Optimization
4. Cost

Selection and Evaluation Criteria

1. Gain
2. Frequency Range
3. Polarization
4. Size and Form Factor
5. Durability and Environmental Ratings
6. Installation and Maintenance Requirements
7. Cost

Antenna Setup



Specific Setup

Details

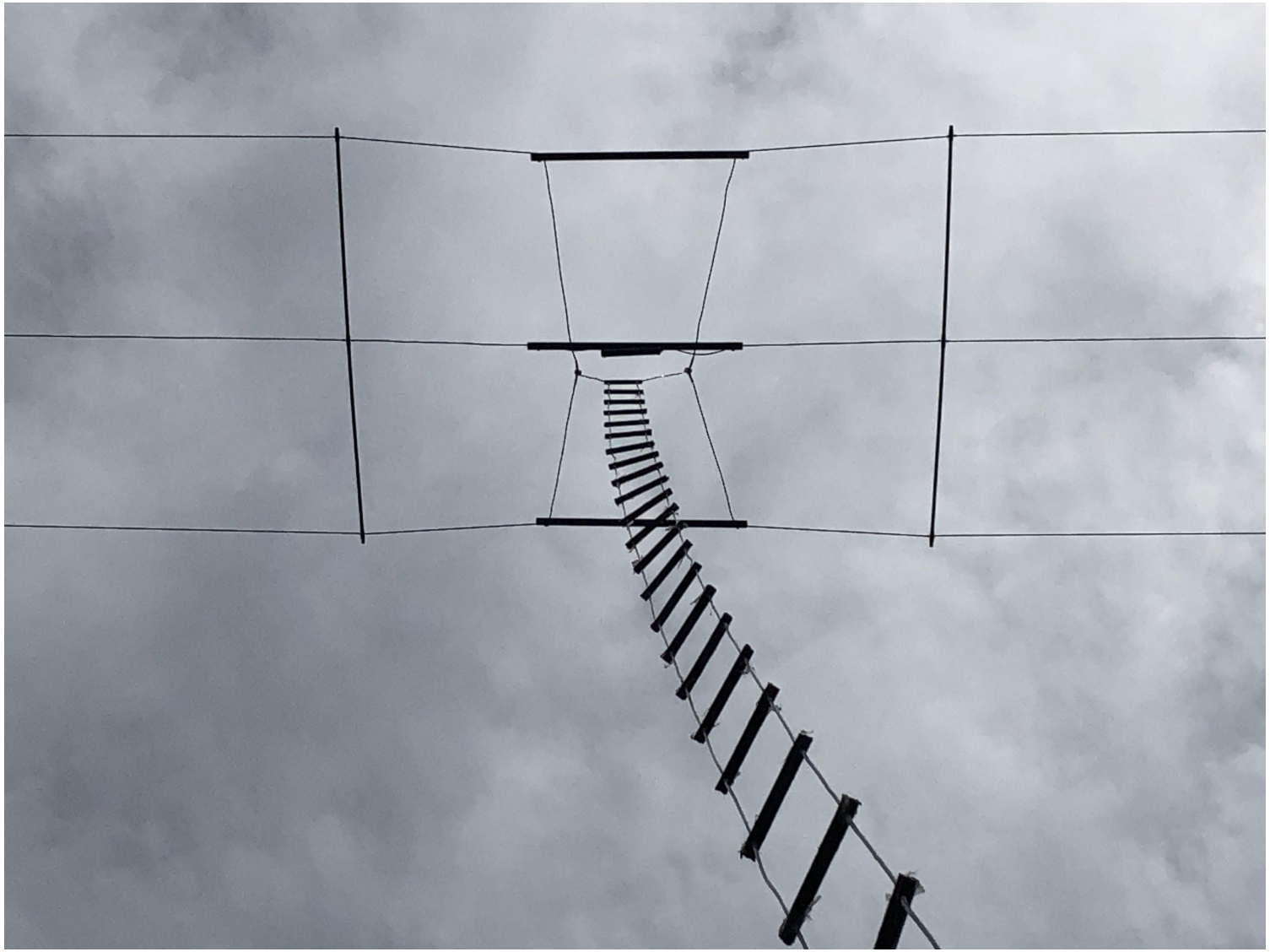
ANTENNAS:

1. **DX Engineering Antenna**: active monopole over ground with
   https://www.dxengineering.com/parts/dxe-rseav-1
2. **Single Antenna System**: active probe dipole
   http://www.sonic.net/~n6gn/OSHW/BB/SA/SingleAntennaSystem.html
3. **LZ1AQ**: active loop dipole
   https://active-antenna.eu/
4. **Ad Hoc Antenna**: passive terminated 3-element folded dipole
   https://dipolesusa.com/store/p76/T3FD90ANTENNAKIT.html

SITES:

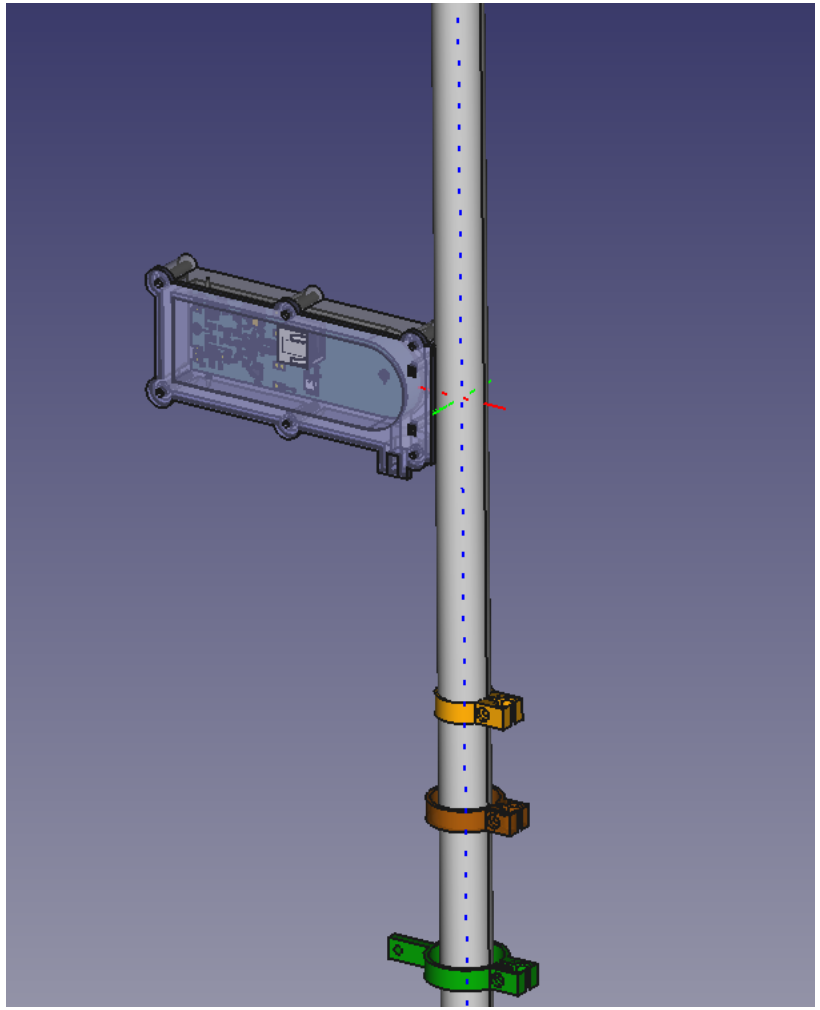
- N6GN (SAS) in Colorado
- N3AGE (SAS) in Long Island, NY
- AC0G (SAS, DXE, T3FD, LZ1AQ) in semi-rural Missouri
- KV0S (DXE) in urban Missouri

Terminated 3-Element Folded Dipole (T3FD)



DX Engineering Monopole

N6GN Single Antenna System



ac0g@hauan.org

LZ1AQ Loop Dipole

Methodology

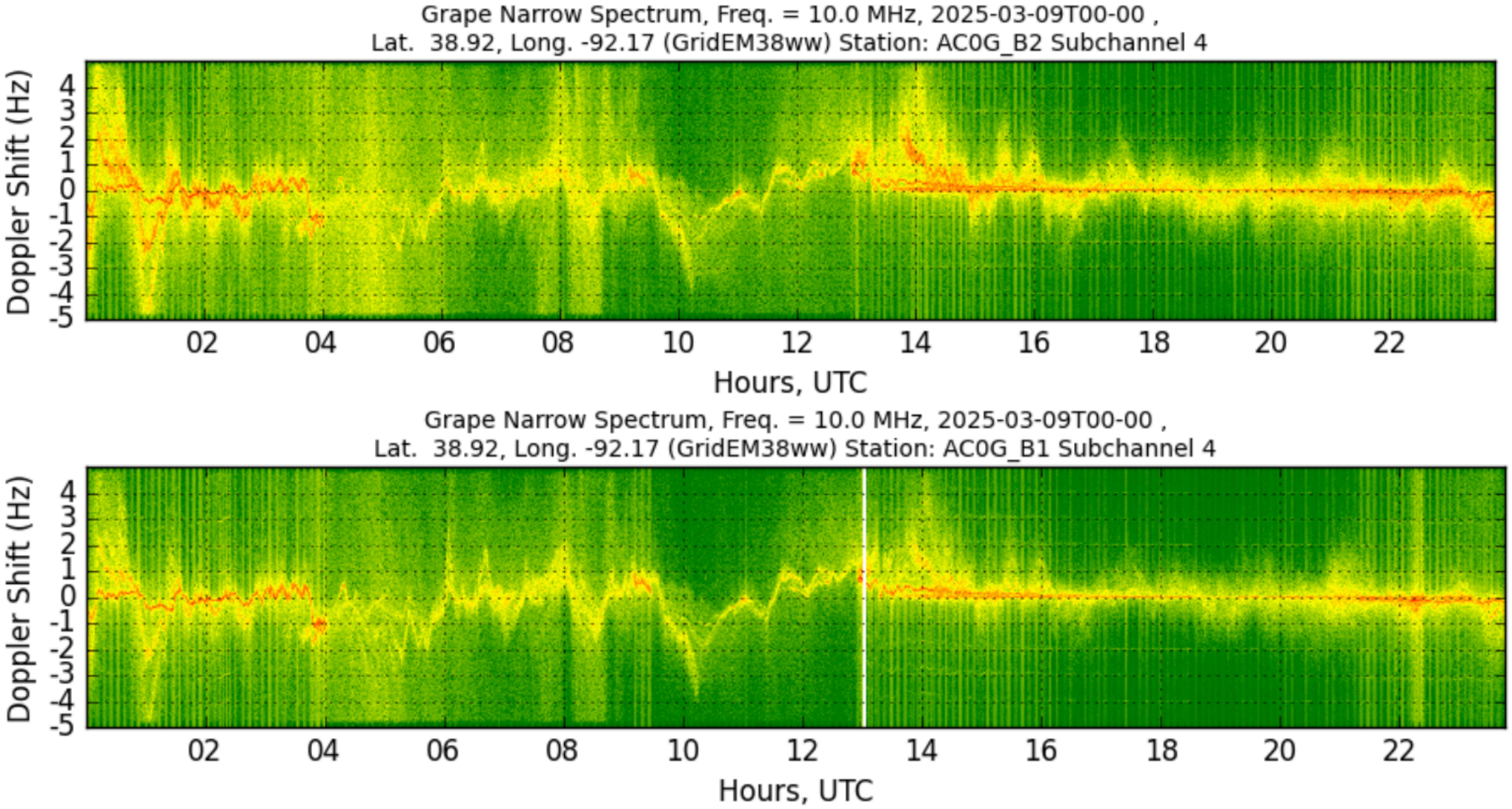
TOOLS:

- ka9q-radio
- ka9q-web spectrum display
- field-probe

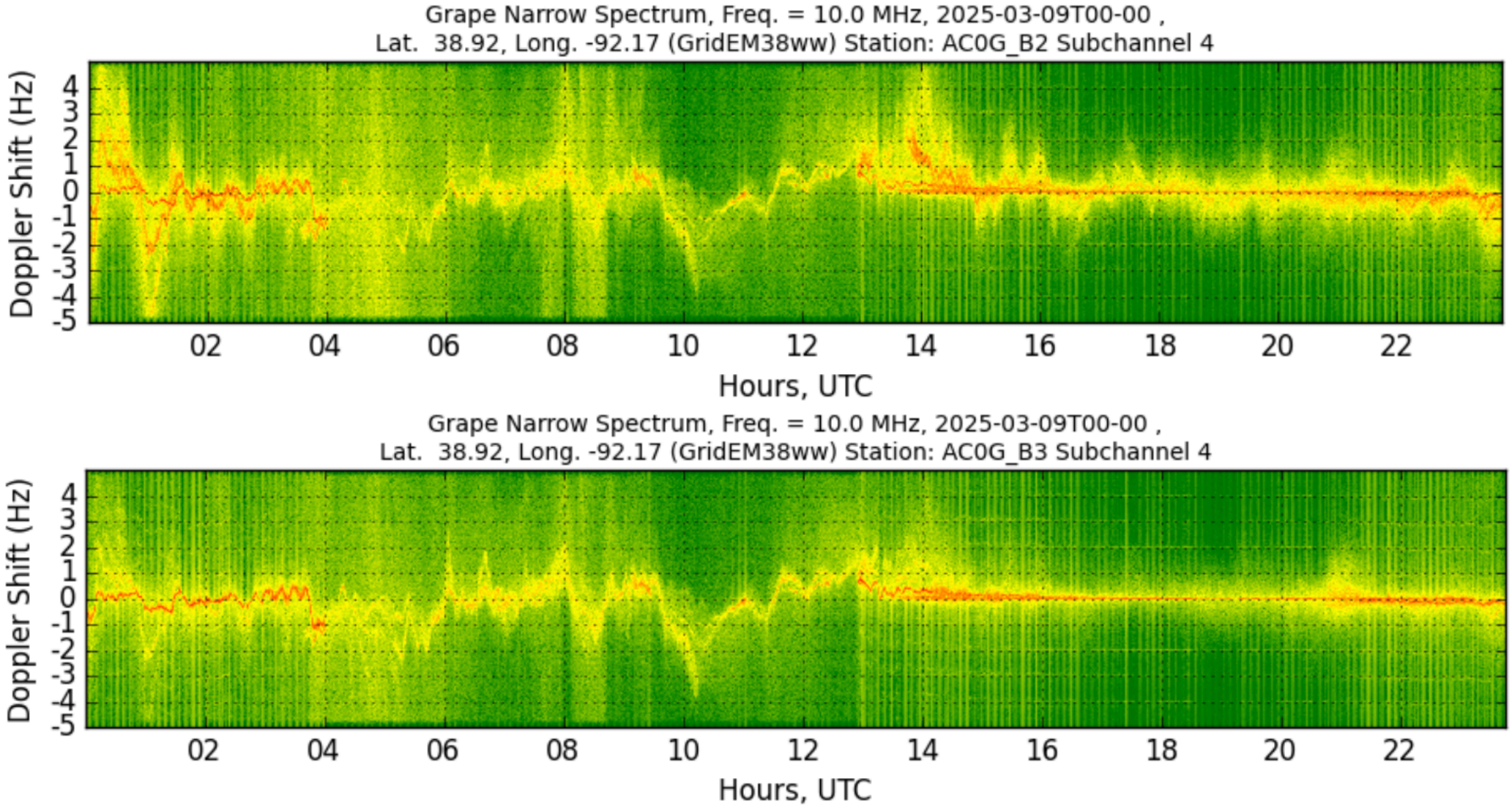
METRICS:

- PSWS spectrograph comparison (https://pswsnetwork.caps.ua.edu)
- wspr reports (https://wspr.rocks)
- Grafana signal/noise reports (http://logs1.wsprdaemon.org:3000/dashboards)
- pskreporter (https://pskreporter.info)

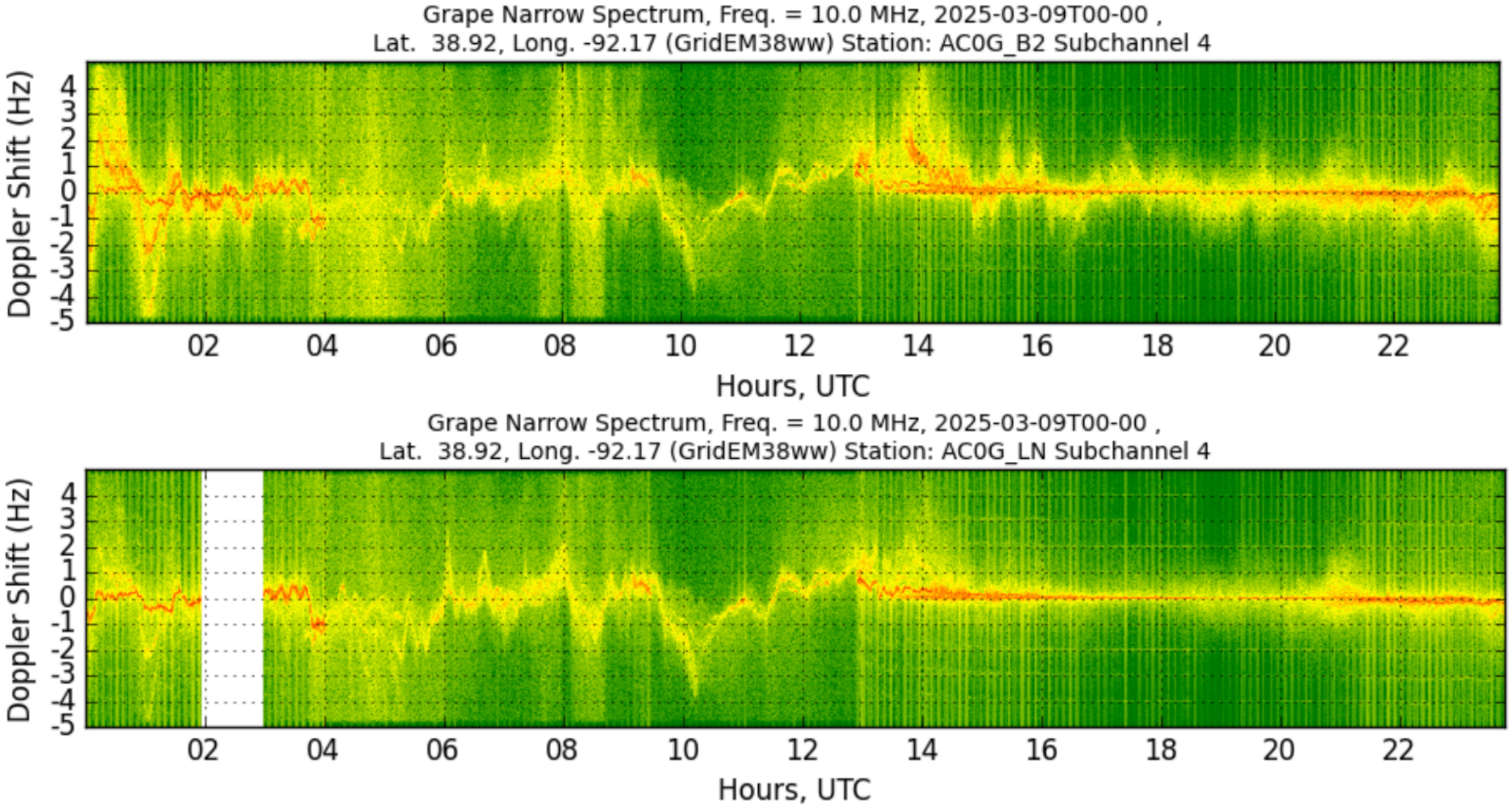
10 MHz – T3FD and LZ1AQ



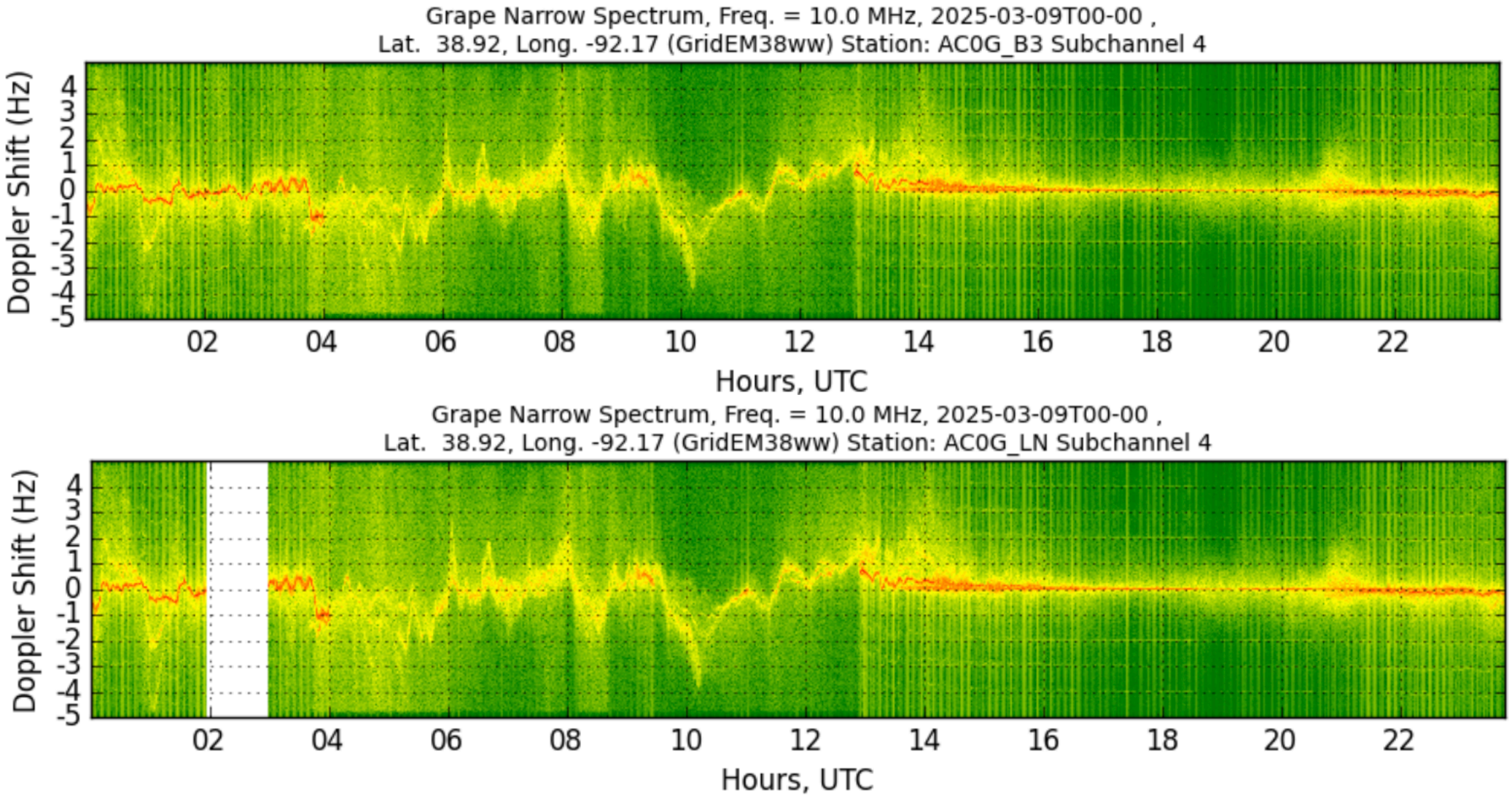
10 MHz – T3FD and SAS1



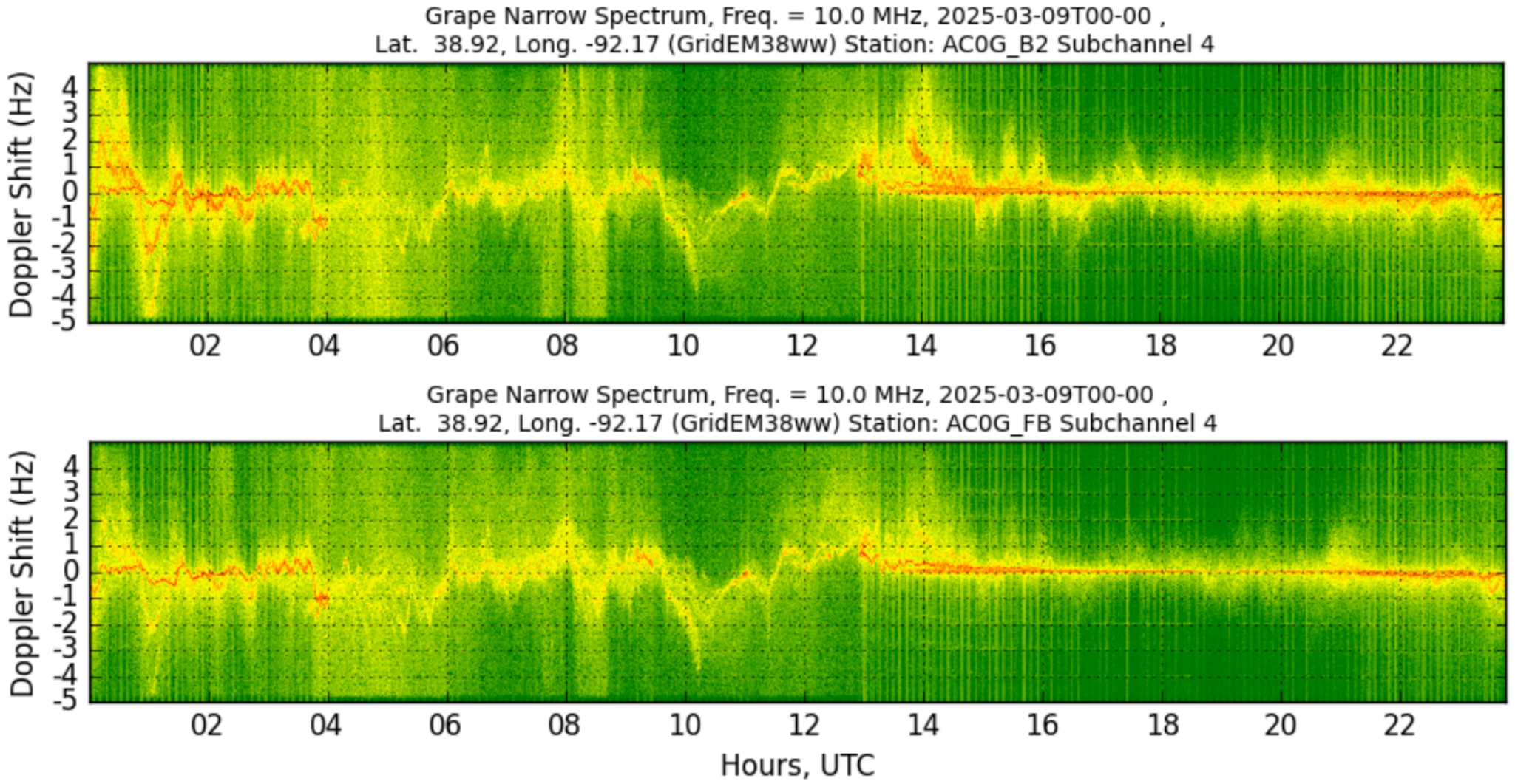
10 MHz – T3FD and SAS2



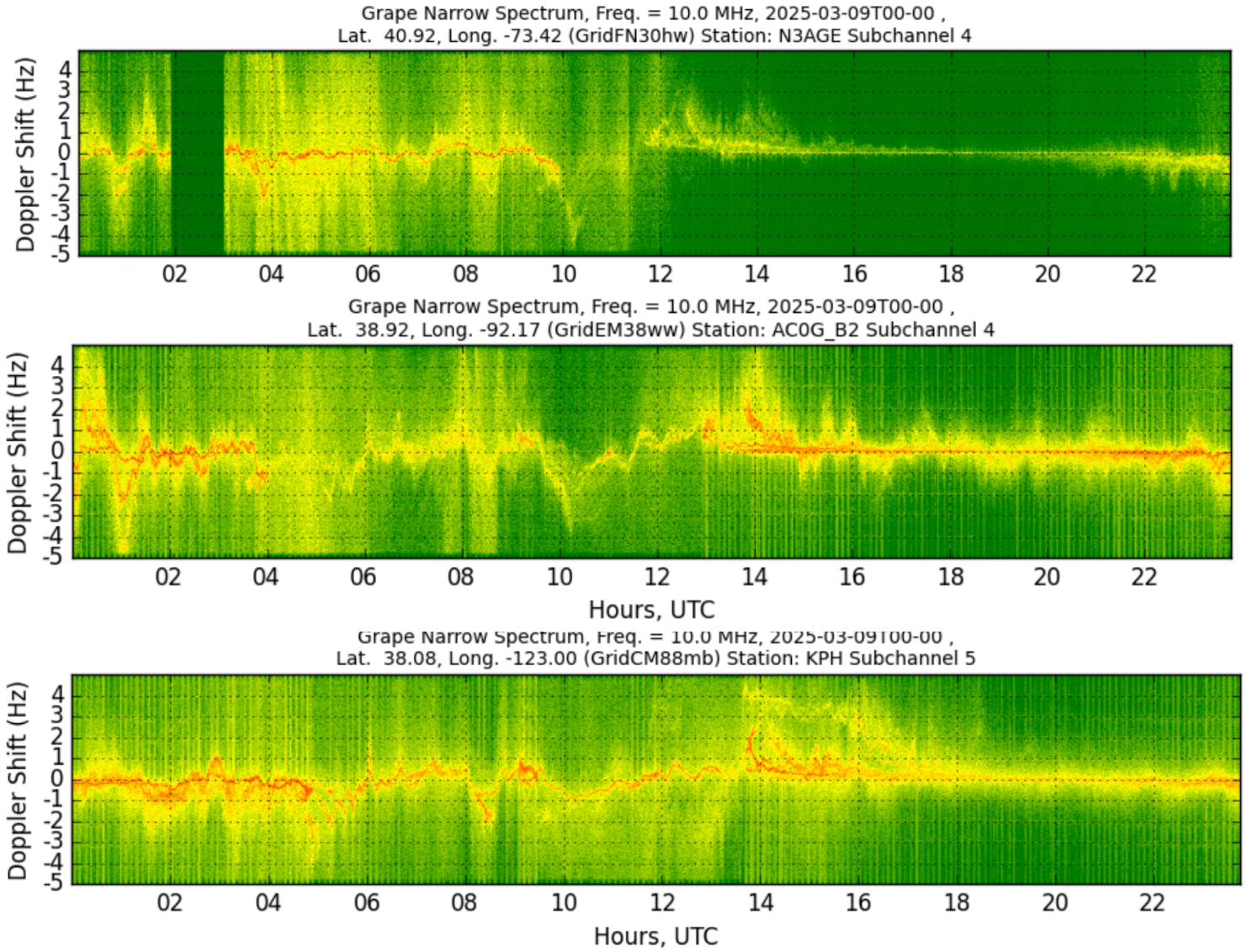
10 MHz – SAS1 and SAS2



10 MHz – T3FD and DXE



10 MHz – N3AGE, AC0G, and KPH



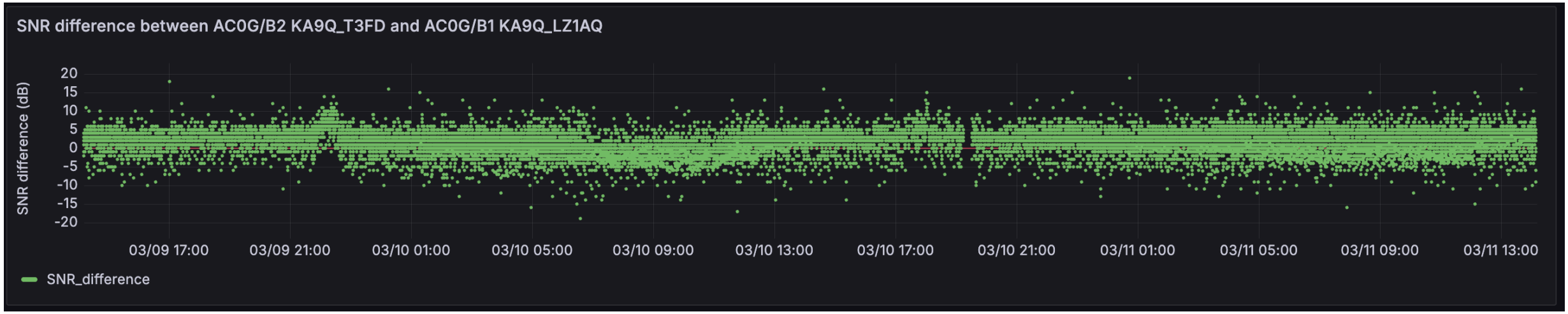
WSPR Spots

=> Displaying data from toStartOfDay (yesterday()) to toStartOfDay (today()) UTC

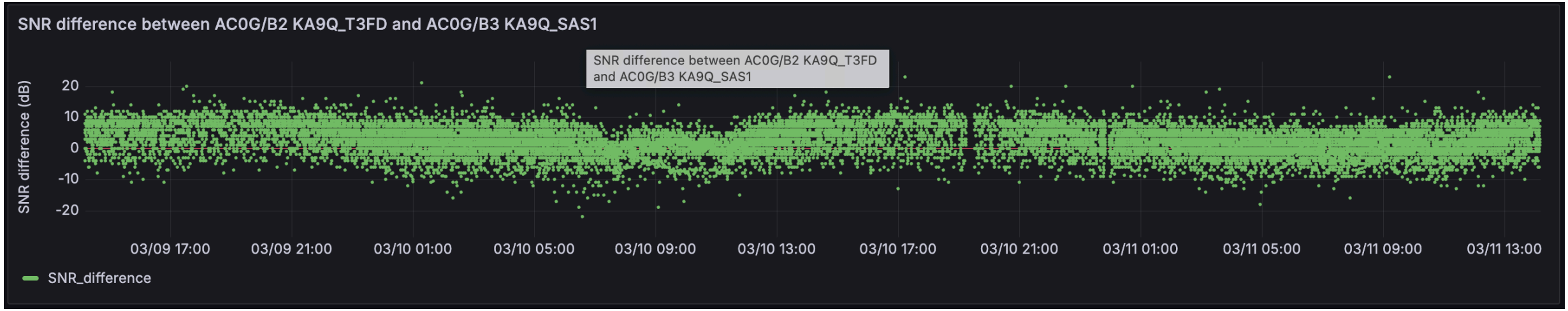
rank	reporter	locator	#raw	#dupes	#unique	LF	MF	160m	80m	60m	40m	30m	20m	17m	15m	12m	10m
	Totals =>	9	344,105	0	12,293	7	92	69	767	33	2,243	1,809	2,845	1,351	1,343	652	1,082
1	AC0G/B2	EM38ww	49862	0	1626	0	14	7	100	3	292	240	353	173	183	103	155
2	AC0G/B3	EM38ww	47634	0	1571	2	17	14	103	3	289	232	343	163	167	88	149
3	AC0G/B1	EM38ww	47561	0	1559	1	5	13	102	4	277	225	342	158	177	100	153
4	AC0G/LN	EM38ww	42885	0	1421	1	10	5	70	2	267	231	327	151	161	72	123
5	KV0S	EM38tv	33594	0	1301	0	9	6	86	5	258	208	288	151	131	65	92
6	AC0G/FB	EM38ww	32092	0	1095	0	11	5	91	2	242	138	296	107	97	39	66
7	N6GN4	DN70ll	31459	0	1178	1	16	3	76	2	220	129	249	144	146	72	120
8	N3AGE-4	FN30hw	29605	0	1286	1	5	8	70	6	202	204	325	154	139	57	113
9	N3AGE-2	FN30hw	29413	0	1270	1	5	8	69	6	196	202	322	150	142	56	111

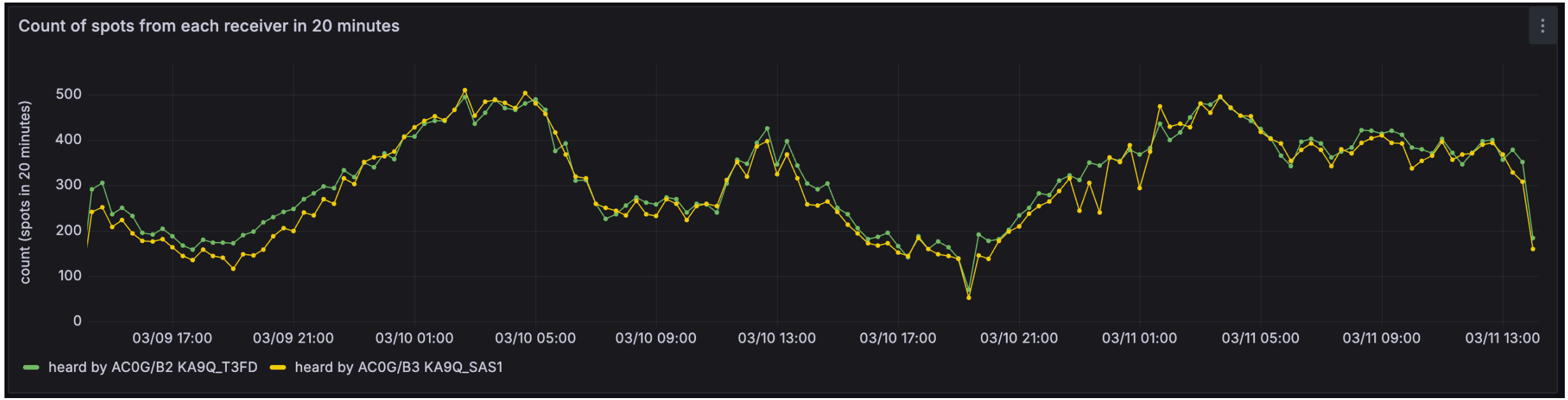
Single Antenna System: 2, 4, 7, 8, 9
DX Engineering: 5, 6
T3FD: 1

Grafana – T3FD and LZ1AQ

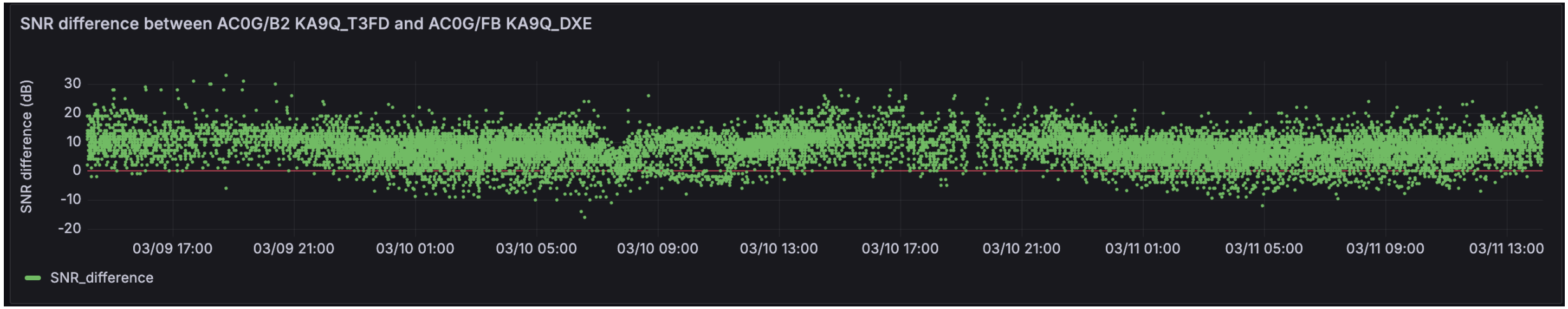


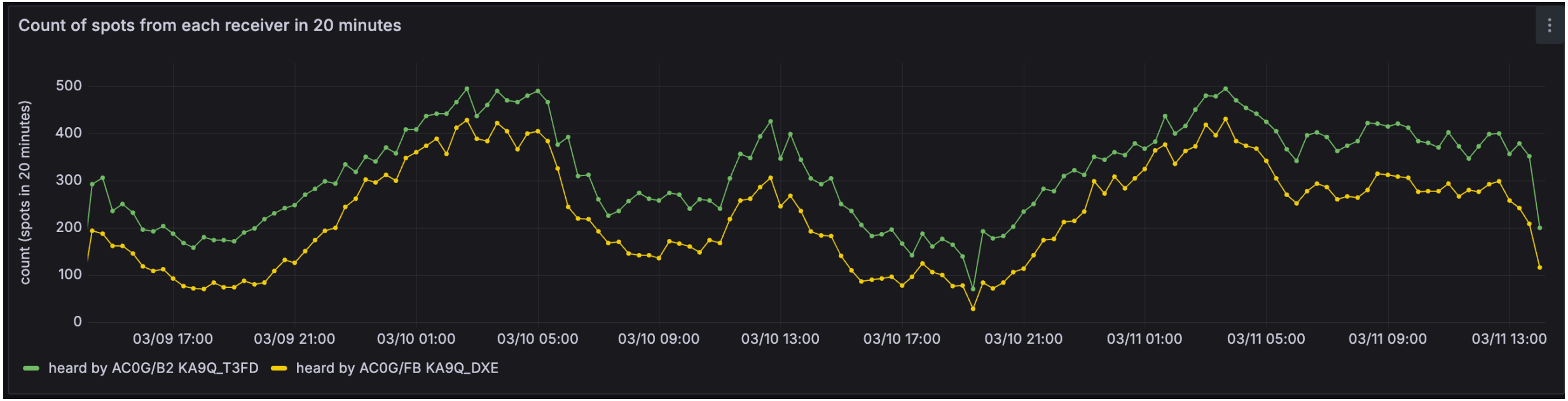
Grafana – T3FD and SAS1



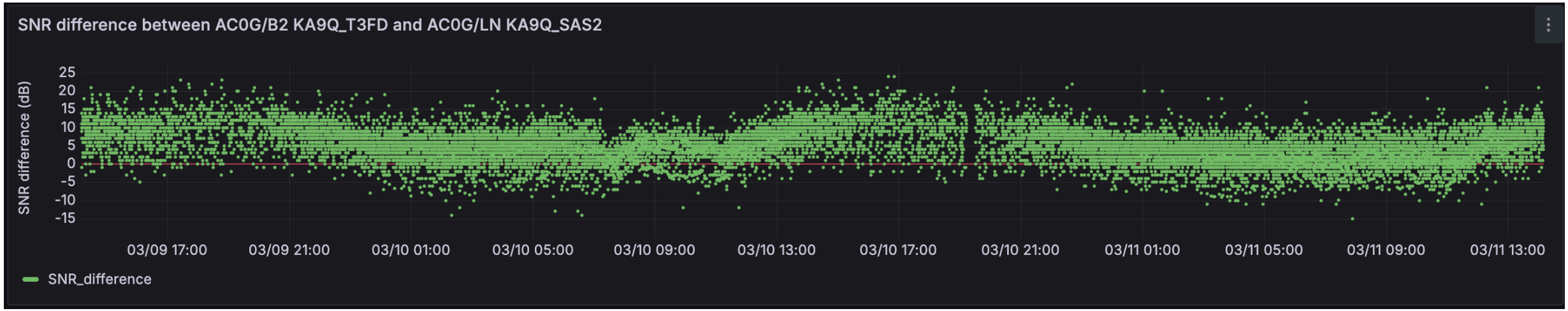


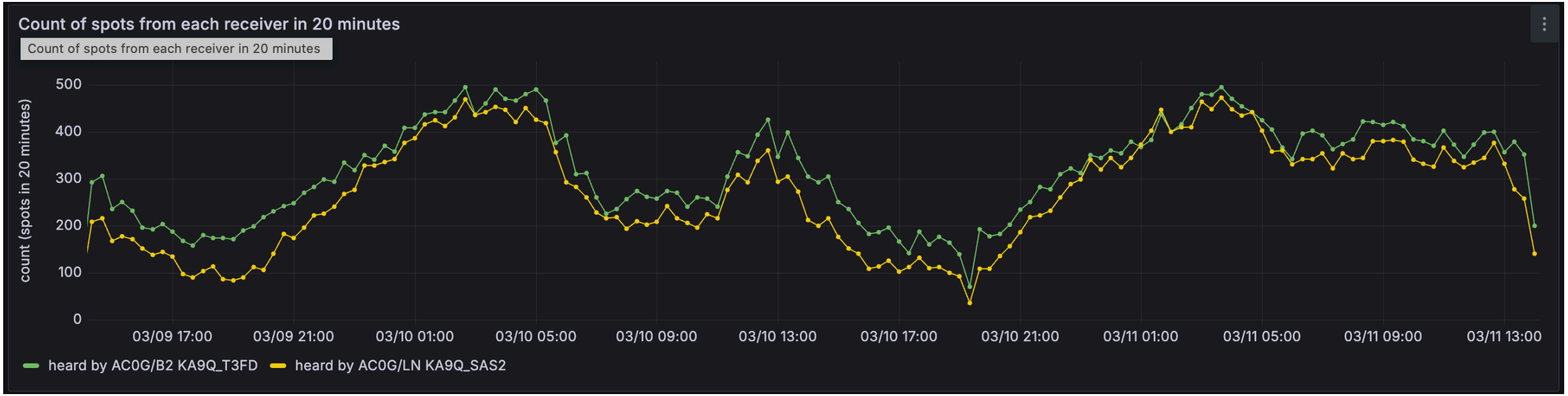
Grafana – T3FD and DXE





Grafana – T3FD and SAS2



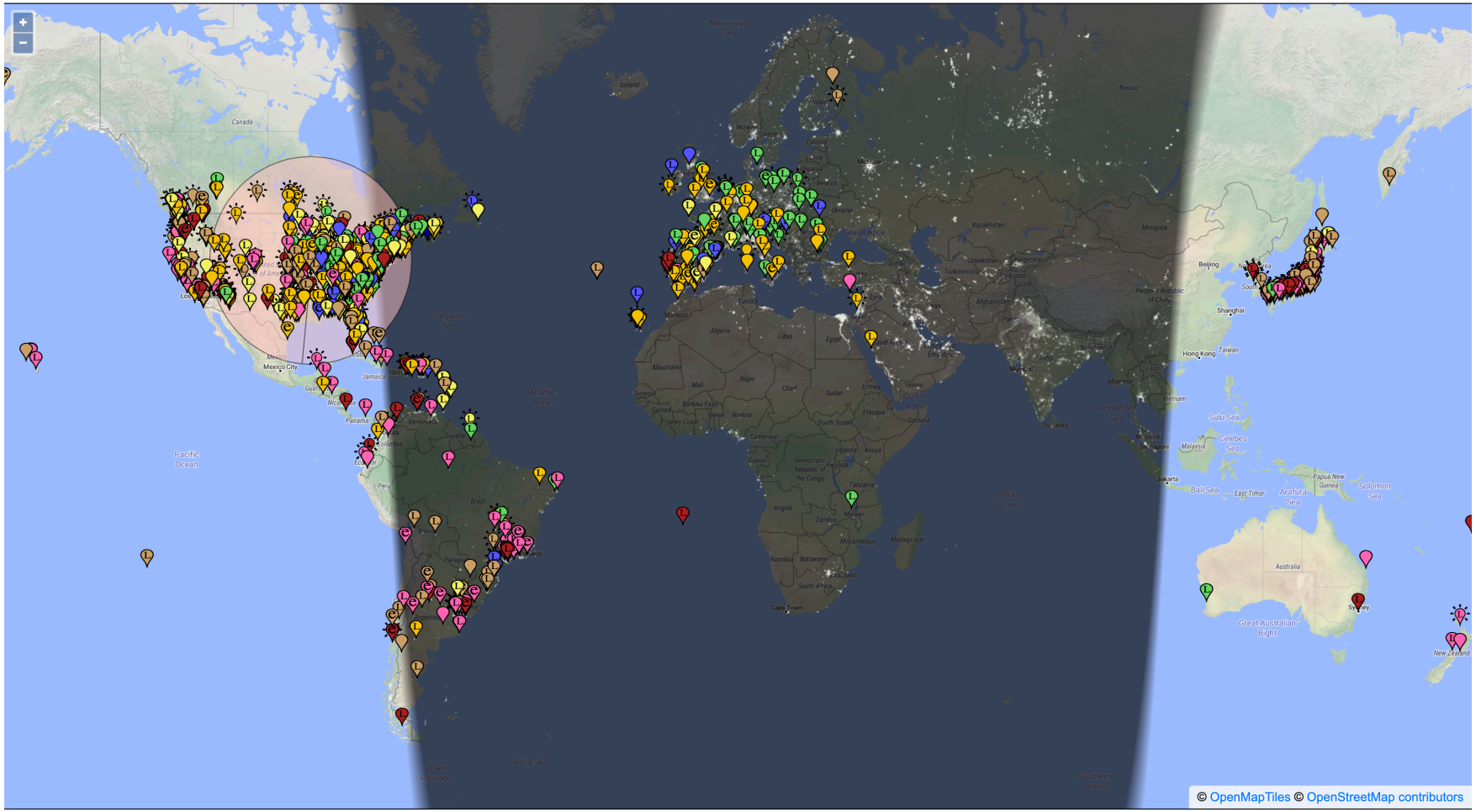


PSKReporter

On all bands, show signals sent/rcvd by the callsign AC0G/B1 using all modes over the last 1 hour Go! Display options Permalink

Monitoring AC0G/B1 (last report 3 mins ago). Automatic refresh in 4 minutes. Small markers are the 1328 transmitters (show logbook) heard (distance chart) at AC0G/B1 (33892 reports, 140 countries last 24 hours; 241766 reports, 151 countries last week).

There are 6711 active monitors: 1620 on 20m, 1431 on 40m, 1316 on 10m, 943 on 15m, 874 on 30m, 690 on 17m, 606 on 80m, 593 on 12m, 533 on 6m, 238 on 160m, 238 on 60m, 122 on 2m, 35 on unknown, 29 on 600m, 17 on 11m, 14 on 2.4Ghz, 9 on 2200m, 9 on 10Ghz, 6 on 23cm, 6 on 70cm, 5 on invalid, 2 on 4m, 2 on 8m. Legend



Statistics — Comments to Philip Gladstone — Online discussions — Reception records: 55,282,708,263 — Hosting by Fast Serv Networks, LLC

PSKREPORTER.INFO

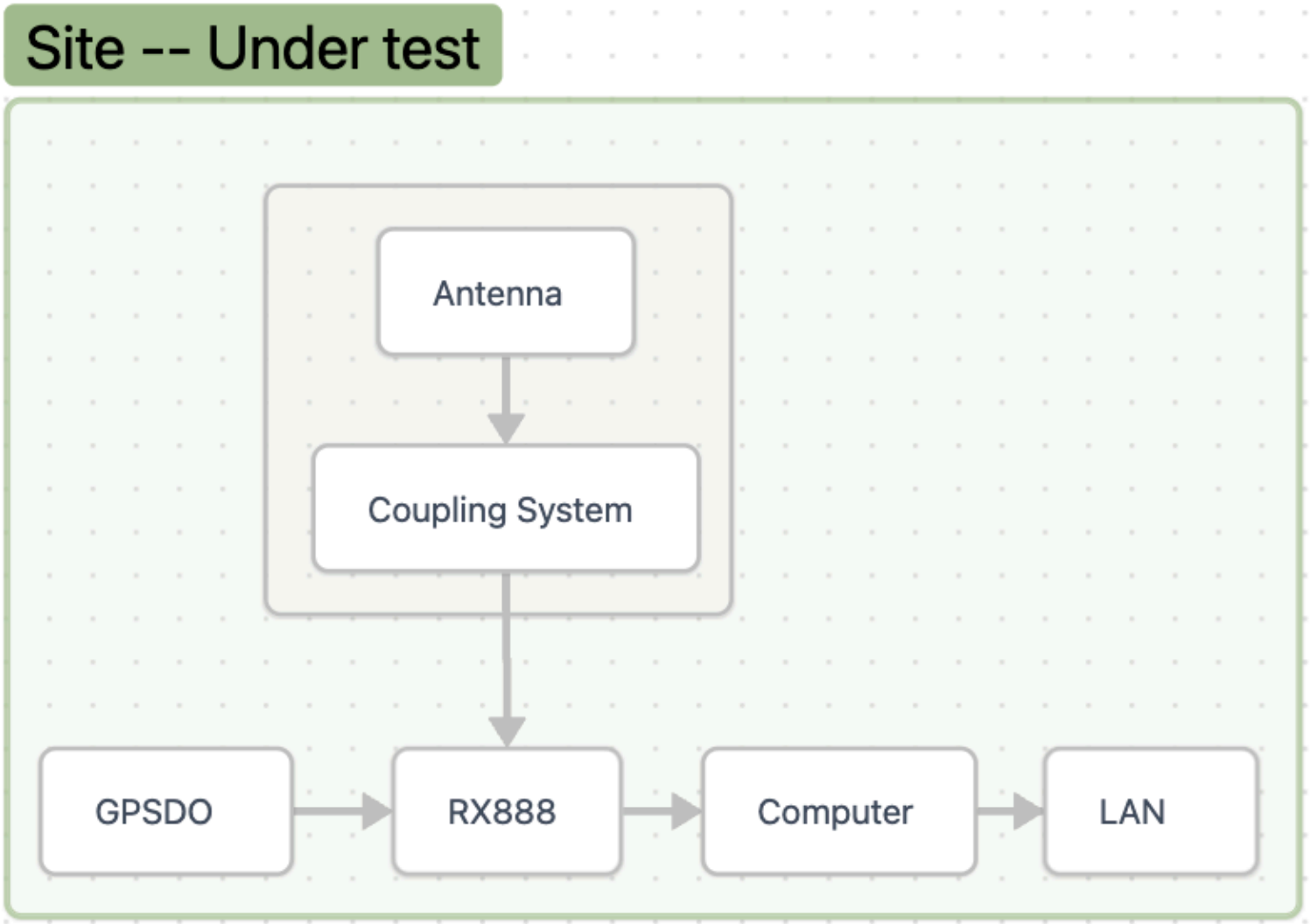
Preliminary Impressions

Antenna:	Performance	Installation Difficulty	Form Factor	Durability	Approximate Cost	Extras Required
T3FD	local gold standard	complex	Huge	high	$700	poles, coax, LPF
DXE	lags but ok	medium	vertical	high	$250	ground rod, coax, LPF
SAS	approaching GS	medium	vertical	TBD	$300	coax, LPF
LZ1AQ	approaching GS	complex	variable	depends	$125	structure, coax, LPF

Remaining Questions

- - Final structure for SAS
- - Interaction of active HF antenna with VLF antenna
- - Site selection requirements
- - Assembly and support issues

General Implications



Site Issues

- ITU region noise and beyond
- Known local broadcast stations
- Nearby structures -- trees, building, geography
- social -- HOA rules
- neighborhood noise
- residence noise
- shack noise

ka9q-web

John Melton G0ORX started this with a proof-of-concept version in late 2023. This adjunct to ka9q-radio displays a spectrum, waterfall, and other data from radiod. **Franco Venturi K4VZ** helped initially incorporate it into wsprdaemon. **Scott Newell N5TNL** has since improved it dramatically in collaboration with **Rob Robinett AI6VN**, **Phil Karn KA9Q**, **Glenn Elmore N6GN**, **Jim Lill WA2ZKD**, and desultory kibbitzers.

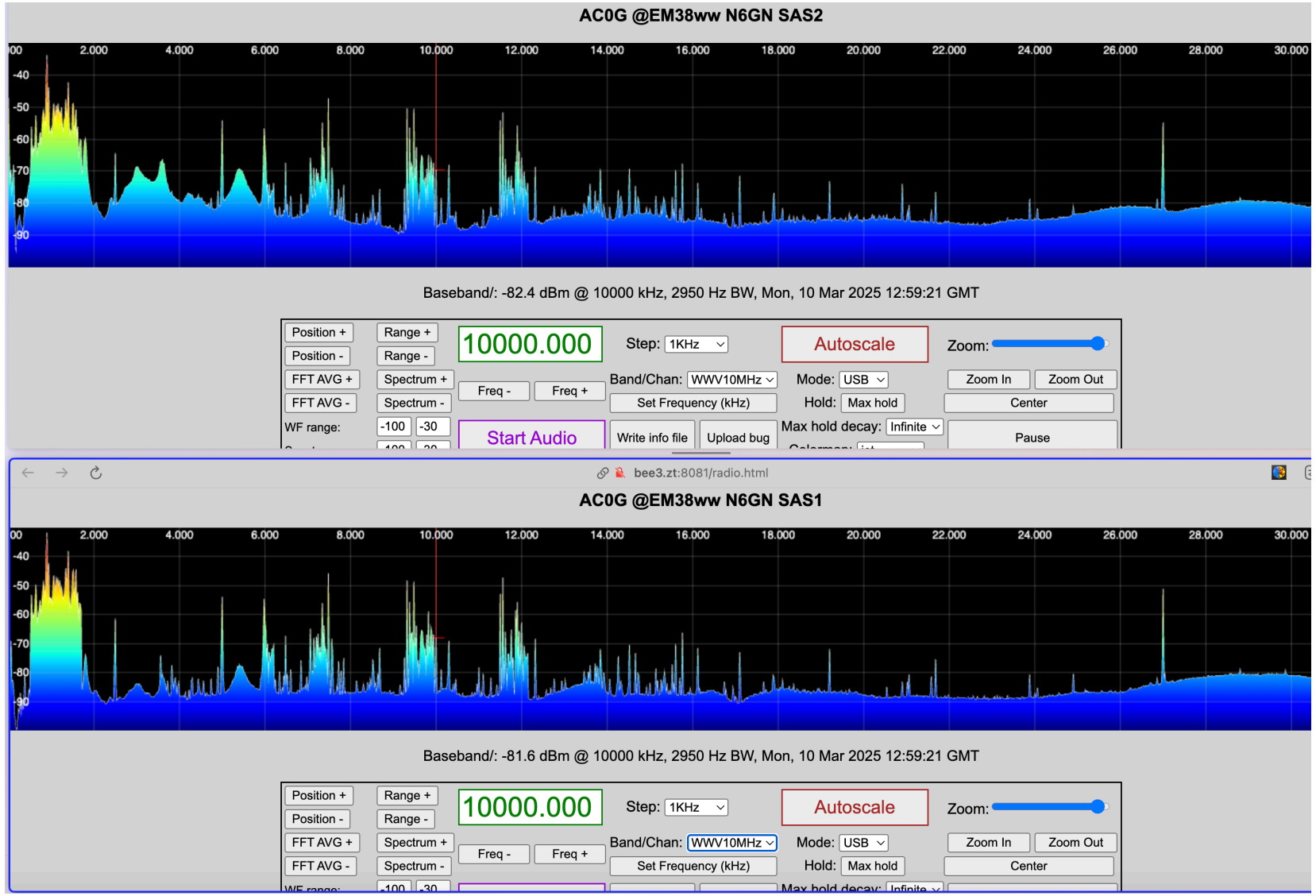
Web Server by John Melton, G0ORX (https://github.com/g0orx/ka9q-radio)

ka9q-radio by Phil Karn, KA9Q (https://github.com/ka9q/ka9q-radio)

Onion Web Framework by David Moreno (https://github.com/davidmoreno/onion)

Spectrum/Waterfall Display by Jeppe Ledet-Pedersen (https://github.com/jledet/waterfall)

SAS1 and SAS2 – 1300 UTC


AC0G @EM38ww N6GN SAS2
2.000 4.000 6.000 8.000 10.000 12.000 14.000 16.000 18.000 20.000 22.000 24.000 26.000 28.000 30.000
-40 -50 -60 -70 -80 -90
Baseband/: -82.4 dBm @ 10000 kHz, 2950 Hz BW, Mon, 10 Mar 2025 12:59:21 GMT
Position + Range + 10000.000 Step: 1KHz Autoscale Zoom:
Position - Range -
FFT AVG + Spectrum + Freq - Freq + Band/Chan: WWV10MHz Mode: USB Zoom In Zoom Out
FFT AVG - Spectrum - Set Frequency (kHz) Hold: Max hold Center
WF range: -100 -30 Start Audio Write info file Upload bug Max hold decay: Infinite Pause
bee3.zt:8081/radio.html
AC0G @EM38ww N6GN SAS1
2.000 4.000 6.000 8.000 10.000 12.000 14.000 16.000 18.000 20.000 22.000 24.000 26.000 28.000 30.000
-40 -50 -60 -70 -80 -90
Baseband/: -81.6 dBm @ 10000 kHz, 2950 Hz BW, Mon, 10 Mar 2025 12:59:21 GMT
Position + Range + 10000.000 Step: 1KHz Autoscale Zoom:
Position - Range -
FFT AVG + Spectrum + Freq - Freq + Band/Chan: WWV10MHz Mode: USB Zoom In Zoom Out
FFT AVG - Spectrum - Set Frequency (kHz) Hold: Max hold Center

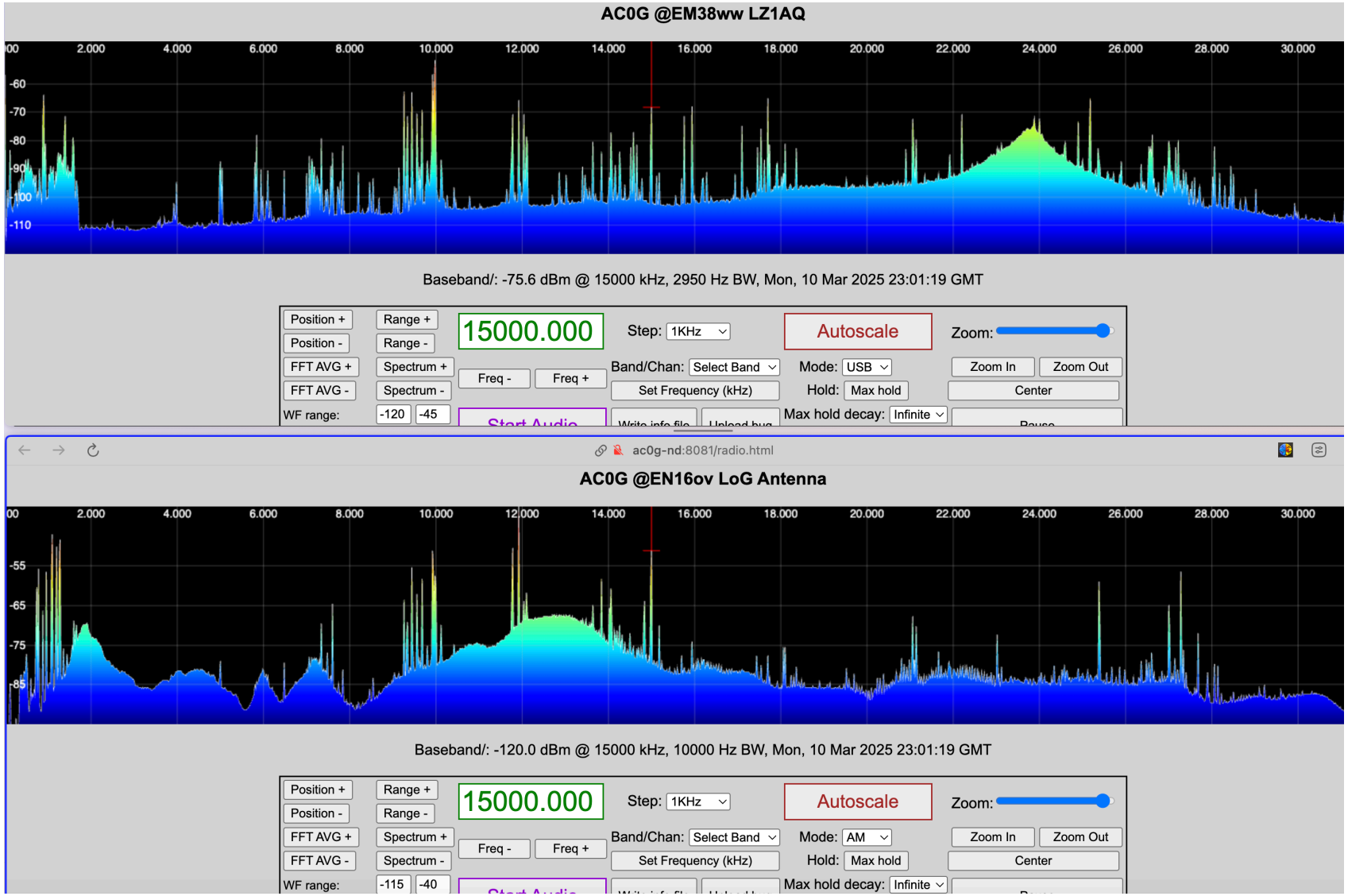
SAS1 and SAS2 – 2300 UTC

AC0G @EM38ww N6GN SAS2
2.000 4.000 6.000 8.000 10.000 12.000 14.000 16.000 18.000 20.000 22.000 24.000 26.000 28.000 30.000
-45 -55 -65 -75 -85
Baseband/: -89.3 dBm @ 10035 kHz, 10000 Hz BW, Mon, 10 Mar 2025 22:52:49 GMT
Position + Range + 10035.000 Step: 1KHz Autoscale Zoom:
Position - Range -
FFT AVG + Spectrum + Freq - Freq + Band/Chan: Select Band Mode: AM Zoom In Zoom Out
FFT AVG - Spectrum - Set Frequency (kHz) Hold: Max hold Center
WF range: -95 -30 Start Audio Write info file Upload bug Max hold decay: Infinite Pause
bee3.zt:8081/radio.html
AC0G @EM38ww N6GN SAS1
2.000 4.000 6.000 8.000 10.000 12.000 14.000 16.000 18.000 20.000 22.000 24.000 26.000 28.000 30.000
-45 -55 -65 -75 -85
Baseband/: -72.6 dBm @ 9988 kHz, 10000 Hz BW, Mon, 10 Mar 2025 22:52:49 GMT
Position + Range + 9988.000 Step: 1KHz Autoscale Zoom:
Position - Range -
FFT AVG + Spectrum + Freq - Freq + Band/Chan: Select Band Mode: AM Zoom In Zoom Out
FFT AVG - Spectrum - Set Frequency (kHz) Hold: Max hold Center
WF range: -105 -30 Start Audio Write info file Upload bug Max hold decay: Infinite Pause

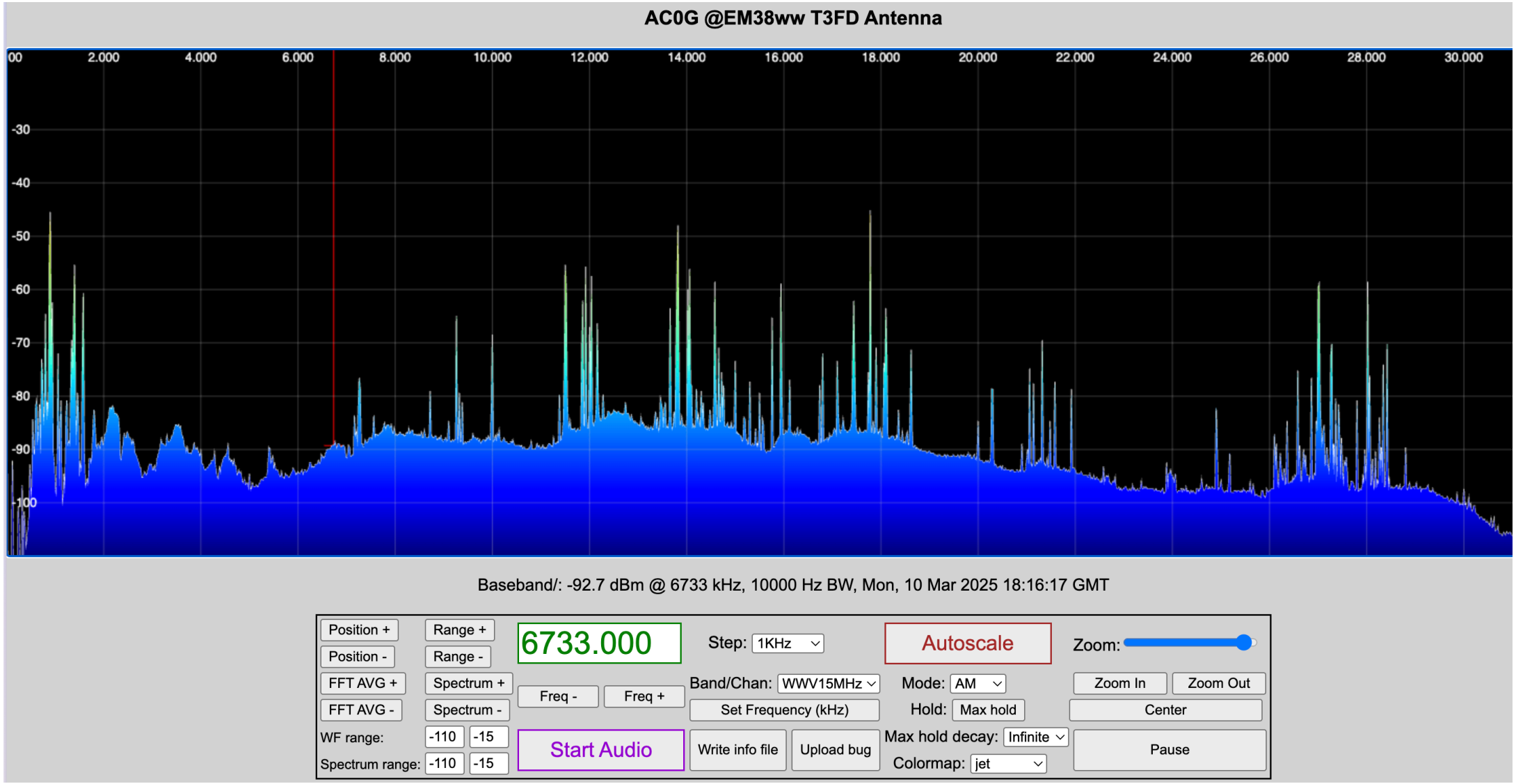
T3FD and DXE

AC0G @EM38ww T3FD Antenna
2.000 4.000 6.000 8.000 10.000 12.000 14.000 16.000 18.000 20.000 22.000 24.000 26.000 28.000 30.000
-45 -55 -65 -75 -85
Baseband/: -89.1 dBm @ 6705 kHz, 10000 Hz BW, Mon, 10 Mar 2025 22:56:19 GMT
Position + Range + 6705.000 Step: 1KHz Autoscale Zoom:
Position - Range -
FFT AVG + Spectrum + Freq - Freq + Band/Chan: WWV15MHz Mode: AM Zoom In Zoom Out
FFT AVG - Spectrum - Set Frequency (kHz) Hold: Max hold Center
WF range: -110 -10 Max hold decay: Infinite
firebat.zt:8081/radio.html
AC0G @EM38ww DXE Antenna
2.000 4.000 6.000 8.000 10.000 12.000 14.000 16.000 18.000 20.000 22.000 24.000 26.000 28.000 30.000
-45 -55 -65 -75 -85
Baseband/: -80.3 dBm @ 9939 kHz, 10000 Hz BW, Mon, 10 Mar 2025 22:56:19 GMT
Position + Range + 9939.000 Step: 1KHz Autoscale Zoom:
Position - Range -
FFT AVG + Spectrum + Freq - Freq + Band/Chan: Select Band Mode: AM Zoom In Zoom Out
FFT AVG - Spectrum - Set Frequency (kHz) Hold: Max hold Center
WF range: -100 -30 Start Audio Write info file Upload bug Max hold decay: Infinite Pause

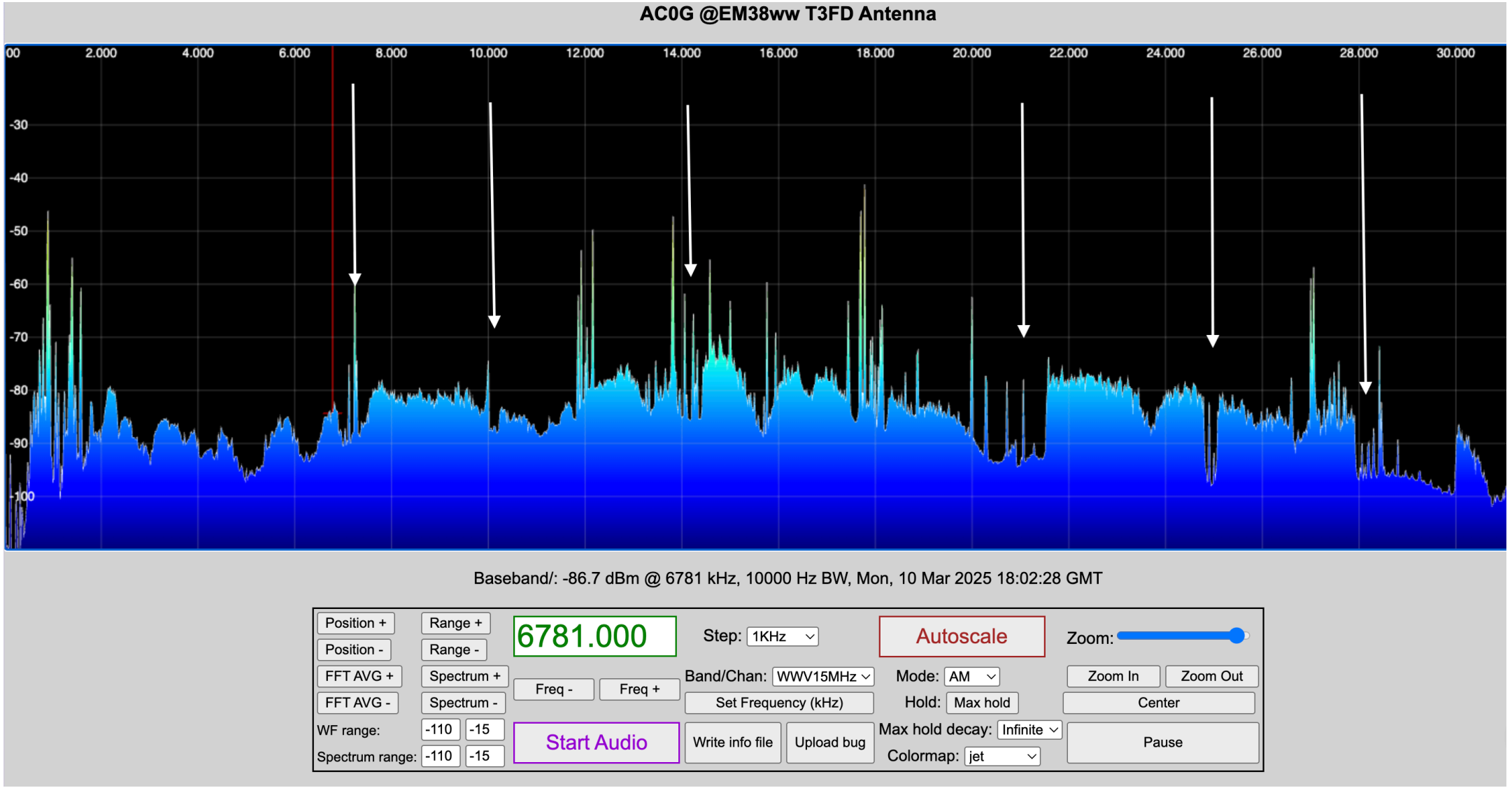
LZ1AQ and LoG


AC0G @EM38ww LZ1AQ
2.000 4.000 6.000 8.000 10.000 12.000 14.000 16.000 18.000 20.000 22.000 24.000 26.000 28.000 30.000
-60 -70 -80 -90 -100 -110
Baseband/: -75.6 dBm @ 15000 kHz, 2950 Hz BW, Mon, 10 Mar 2025 23:01:19 GMT
Position + Position - FFT AVG + FFT AVG - WF range:
Range + Range - Spectrum + Spectrum - -120 -45
15000.000
Freq - Freq +
Step: 1KHz
Band/Chan: Select Band
Set Frequency (kHz)
Autoscale
Mode: USB
Hold: Max hold
Max hold decay: Infinite
Zoom:
Zoom In Zoom Out Center
ac0g-nd:8081/radio.html
AC0G @EN16ov LoG Antenna
2.000 4.000 6.000 8.000 10.000 12.000 14.000 16.000 18.000 20.000 22.000 24.000 26.000 28.000 30.000
-55 -65 -75 -85
Baseband/: -120.0 dBm @ 15000 kHz, 10000 Hz BW, Mon, 10 Mar 2025 23:01:19 GMT
Position + Position - FFT AVG + FFT AVG - WF range:
Range + Range - Spectrum + Spectrum - -115 -40
15000.000
Freq - Freq +
Step: 1KHz
Band/Chan: Select Band
Set Frequency (kHz)
Autoscale
Mode: AM
Hold: Max hold
Max hold decay: Infinite
Zoom:
Zoom In Zoom Out Center

T3FD

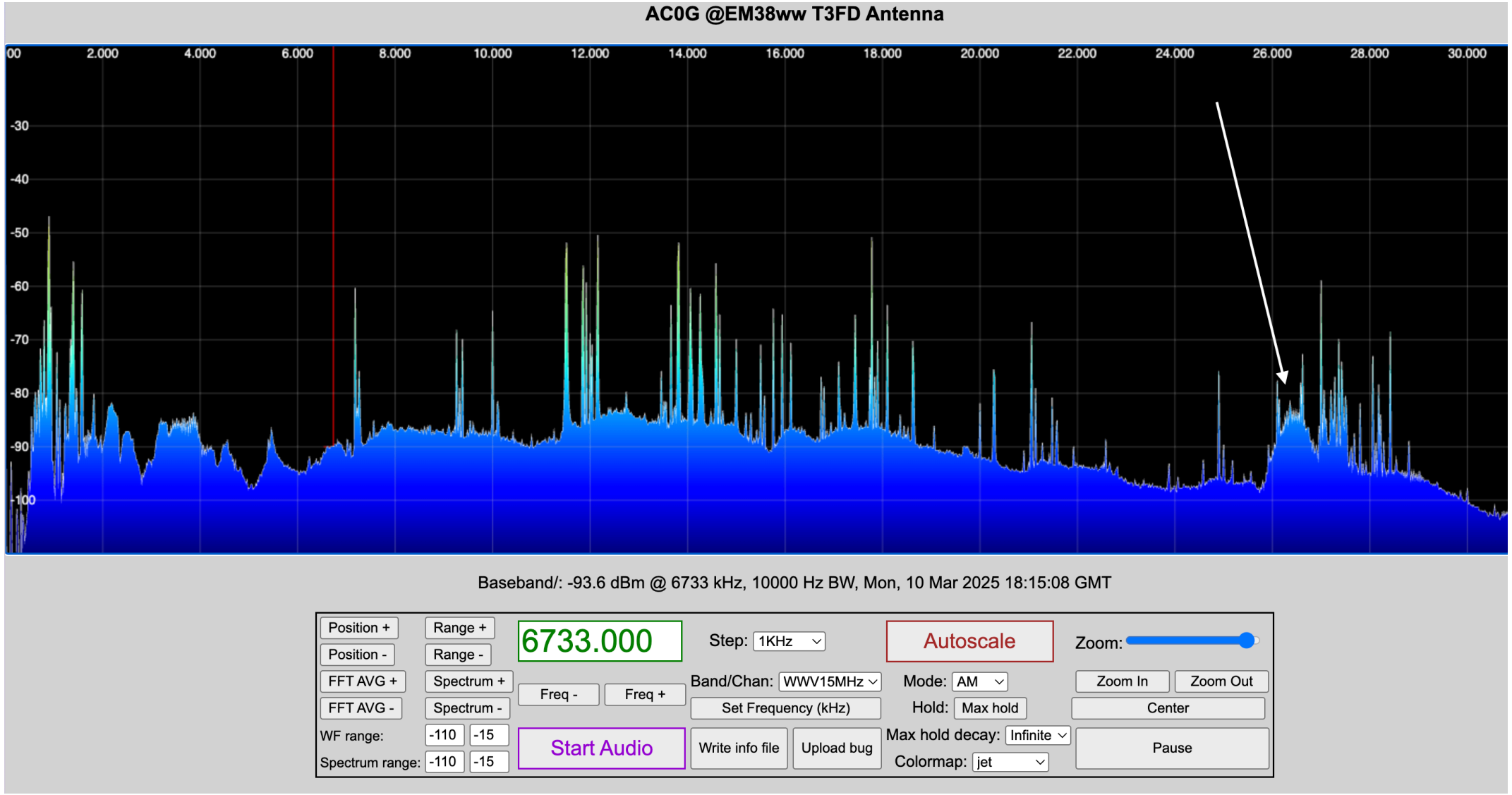

AC0G @EM38ww T3FD Antenna
00 2.000 4.000 6.000 8.000 10.000 12.000 14.000 16.000 18.000 20.000 22.000 24.000 26.000 28.000 30.000
-30
-40
-50
-60
-70
-80
-90
-100
Baseband/: -92.7 dBm @ 6733 kHz, 10000 Hz BW, Mon, 10 Mar 2025 18:16:17 GMT
Position +
Position -
FFT AVG +
FFT AVG -
WF range:
Spectrum range:
Range +
Range -
Spectrum +
Spectrum -
-110
-15
-110
-15
6733.000
Freq -
Freq +
Start Audio
Step: 1KHz
Band/Chan: WWV15MHz
Set Frequency (kHz)
Write info file
Upload bug
Autoscale
Mode: AM
Hold: Max hold
Max hold decay: Infinite
Colormap: jet
Zoom:
Zoom In
Zoom Out
Center
Pause

Noise Patterns



Culprit

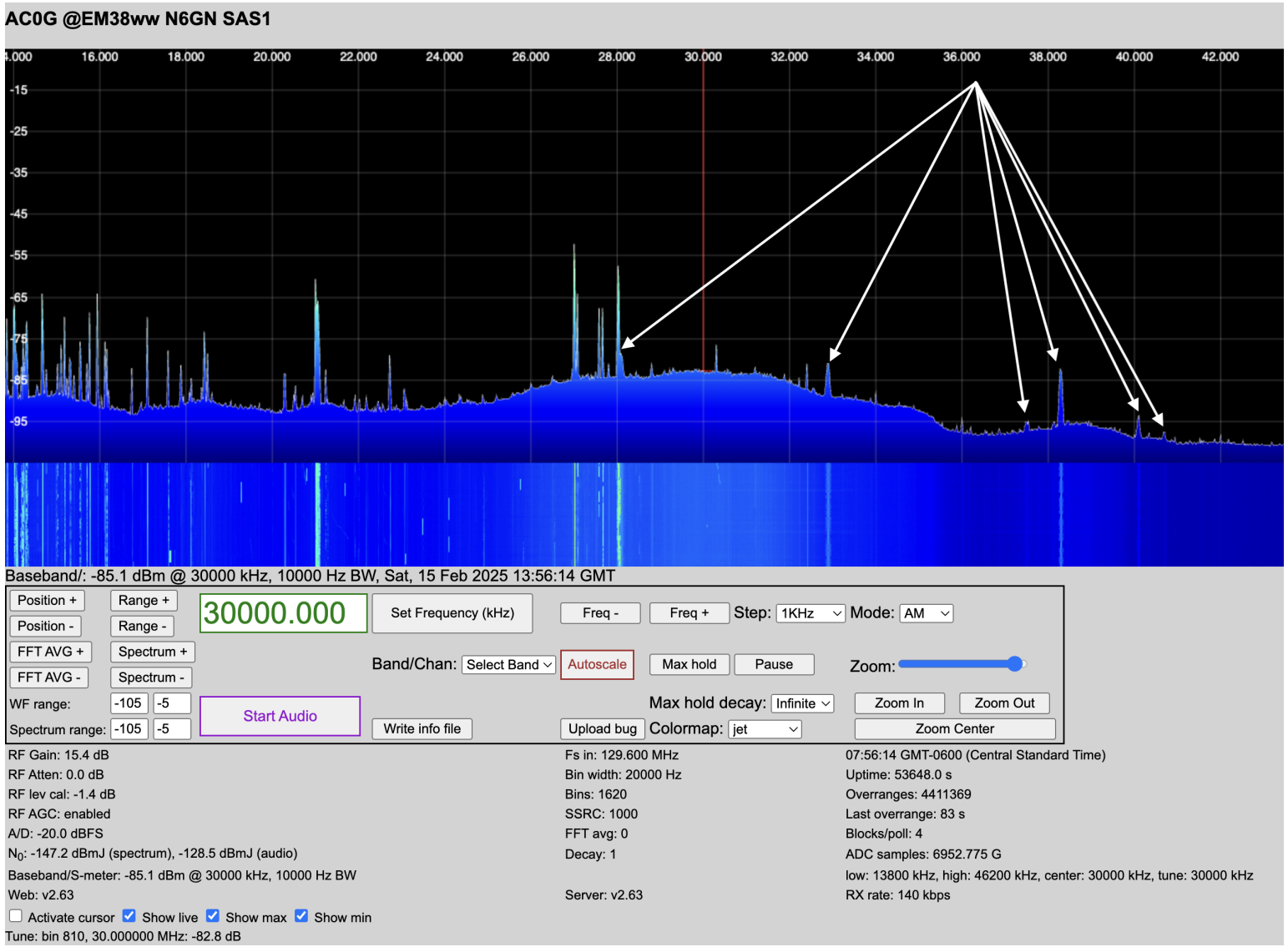
Noise Patterns



Culprit

HITACHI
EBM 1830
BATTERY
18V
Hitachi Koki
CAUTION
HITACHI UC 18YRL

Noise Patterns



Sample rate. St	Observed	
129.6	23.5	106.1
129.6	27.3	102.3
129.6	28.1	101.5
129.6	29.1	100.5
129.6	29.5	100.1
129.6	30.3	99.3
129.6	30.7	98.9
129.6	31.3	98.3
129.6	32.1	97.5
129.6	32.9	96.7
129.6	33.3	96.3
129.6	33.9	95.7
129.6	34.3	95.3
129.6	35.3	94.3
129.6	35.7	93.9
129.6	36.5	93.1
129.6	37.5	92.1
129.6	38.3	91.3
129.6	39.1	90.5
129.6	40.1	89.5
129.6	40.7	88.9

Summary

- DASI2 antenna
- Site analysis
- Embrace your HAM- and SCI- nature!
- Checkout https://hf-noise.readthedocs.io/ to learn and help me document noise mitigation and site tuning.

Acknowledgments

The HamSCI Community is led by The University of Scranton Department of Physics and Engineering W3USR, in collaboration with Case Western Reserve University W8EDU, the University of Alabama, the New Jersey Institute of Technology Center for Solar Terrestrial Physics K2MFF, the MIT Haystack Observatory, TAPR, additional collaborating universities and institutions, and volunteer members of the amateur radio and citizen science communities.

We are grateful for the financial support of the United States National Science Foundation, NASA, and Amateur Radio Digital Communications (ARDC).

HamSCI silhouette photo by Ann Marie Rogalcheck-Frissell KC2KRQ.

Thank you!

Happy to answer any questions…